LAT Water: Waste heat powered treatment of leachate at Broadpath Landfill, Viridor

Summary

LAT Water has developed an innovative wastewater treatment and separation technology capable of operating using low grade waste heat or renewable energy sources. This provides a major energy saving when treating complex wastewaters, especially those which are collected and trucked off-site for disposal.

Low Temperature Ambient Pressure Technology (LAT™) is a means of producing water from a wide range of waste effluents using waste heat. The LAT™ process solution is applicable to sectors which have tougher highly saline effluents, complex dissolved contaminants and currently require costly treatment schemes. LAT™ has zero emissions to air and water, makes use of waste heat as thermal energy input, produces product water which can be reused and/or recycled, and a product concentrate that can be further treated within existing discharge consents, without the need for new consents and consequently more costs. These allow clients to continue to reduce their energy consumption and lower carbon emissions and meet decarbonisation goals. 48% energy efficiency benefits were achieved by the LAT unit operations by reducing the electrical power from 15kWh/m^3 to 8kWh/m^3. Additional savings were also made specific to the Broadpath site as outlined below.

The Industrial Energy Efficiency Accelerator (IEEA)

The IEEA programme supports the development of innovative technologies that will help industry reduce energy consumption and cut carbon emissions. It focuses on innovations with large potential cross-sector energy and carbon reduction impact - either new technologies or established technologies applied to new sectors. Over £15 million in public and private funding has been committed to develop solutions through partnerships between technology developers and industrial companies willing to test technologies on-site. The programme is funded by the UK government (BEIS) and managed by the Carbon Trust, with support from Jacobs.

Introduction

LAT Water has developed innovative wastewater treatment separation technology, with the ability to use discharged low grade waste heat, e.g., in the form of hot gas from industrial exhausts, reducing total energy consumption by over 70% and offering significant operating cost savings. LAT™ is the only technology offering three solutions in a single step: reduction of high levels of ammonia, reducing dissolved salts and reducing organics. This offers high rates of water recovery and the ability to treat more complex waters than other systems. The project benefitted from £547,000 of BEIS IEEA grant funding that assisted the development of the LAT™ demonstrator unit. LAT Water has also benefitted from business incubation and marketing support from the Carbon Trust.

LAT Water have demonstrated the technology at Broadpath landfill site, operated by Viridor Waste Management Ltd. Leachate is a complex wastewater containing high levels of ammonia, organic matter and dissolved salts. This mix of compounds provides a high level of complexity, and many traditional technologies struggle to treat leachate in a commercially viable or satisfactory manner.

Many sites, including Broadpath landfill, are still collecting and tankering leachate to off-site treatment, at high cost and carbon emissions. By utilising the waste heat provided on-site from bio-gas generators, LAT Water offer an environmentally friendly and sustainable solution to treat leachate on-site. LAT Water leachate treatment systems are designed to recover a minimum of 80% clean water which can be safely discharged or recycled, reducing final treatment costs by up to 50%.

Figure 1 LAT Water demonstration site

'The future of the landfill industry depends on managing the legacy issues of the sites, more than 50% of the costs relate to disposal of the leachate. Reducing these and recovering resources from the leachate is critical for the circular economy – we are excited to be working with LAT Water on achieving these objectives.'

Tim Rotheray,
Director of Innovation and Regulation, Viridor

'We are delighted with the performance of the LAT™ system. The energy reduction, cost savings and reliability have fully demonstrated our ability to treat the most demanding water and varied applications. We'd like to thank Viridor, BEIS, Carbon Trust and Jacobs for their outstanding support in working with us on this demonstration.'

Mark Hardiman,
CEO, LAT Water

About the innovation

- LAT Water has developed wastewater separation technology, producing clean water and a concentrated product stream
- The process uses air movement to transport water vapour from a humidification column to a dehumidification column below the boiling point of water. Medium grade heat (70°C - 95°C) is used to evaporate and condense water in successive “stages”
- The technology is capable of using a wide range of heat sources such as waste heat (hot water, hot gas exhaust), geothermal, solar, or low pressure steam. Use of waste heat allows the productive use of heat sources which would otherwise be polluting and contributing to global warming, thus delivering net carbon savings.
- The latent heat of condensation is recycled with each stage operating at lower temperatures than the previous one
- Each stage produces freshwater and successively concentrates the feed water. Freshwater can be reused and recycled back into operations, and the concentrate further treated to extract added value
- LAT Water differentiates from traditional evaporation and condensation technologies, which use only low pressure steam, require exotic materials, have a single point of failure and need sophisticated pre-treatment
- Wastewaters never contact the atmosphere, so volatile organic compounds (VOCs) are not released, unlike conventional open to atmosphere evaporators that boil water directly to atmosphere with potential for air emissions and health and safety concerns

The demonstration

The process flow diagram shows how LAT™ recirculates leachate and clean water at variable temperatures to achieve separation of clean water and concentrate. Thermal energy is provided using the gas generators.

Site

The demonstration site is Viridor’s Broadpath landfill at Uffculme, Devon. There is no treatment process on site and leachate is tankered offsite for final treatment over 60 miles away. LAT Water installed a water treatment system to treat 10m^3/day of leachate.

Waste heat from biogas engines was used as thermal energy input to LAT™ demonstrator plant. LAT Water achieved the targeted minimum clean water recovery of 70%, and a maximum of over 90% leaving a product concentrate to then be disposed of. This would reduce trucking costs, and therefore energy requirements for leachate treatment by up to 70%, and a total cost saving of 50%.

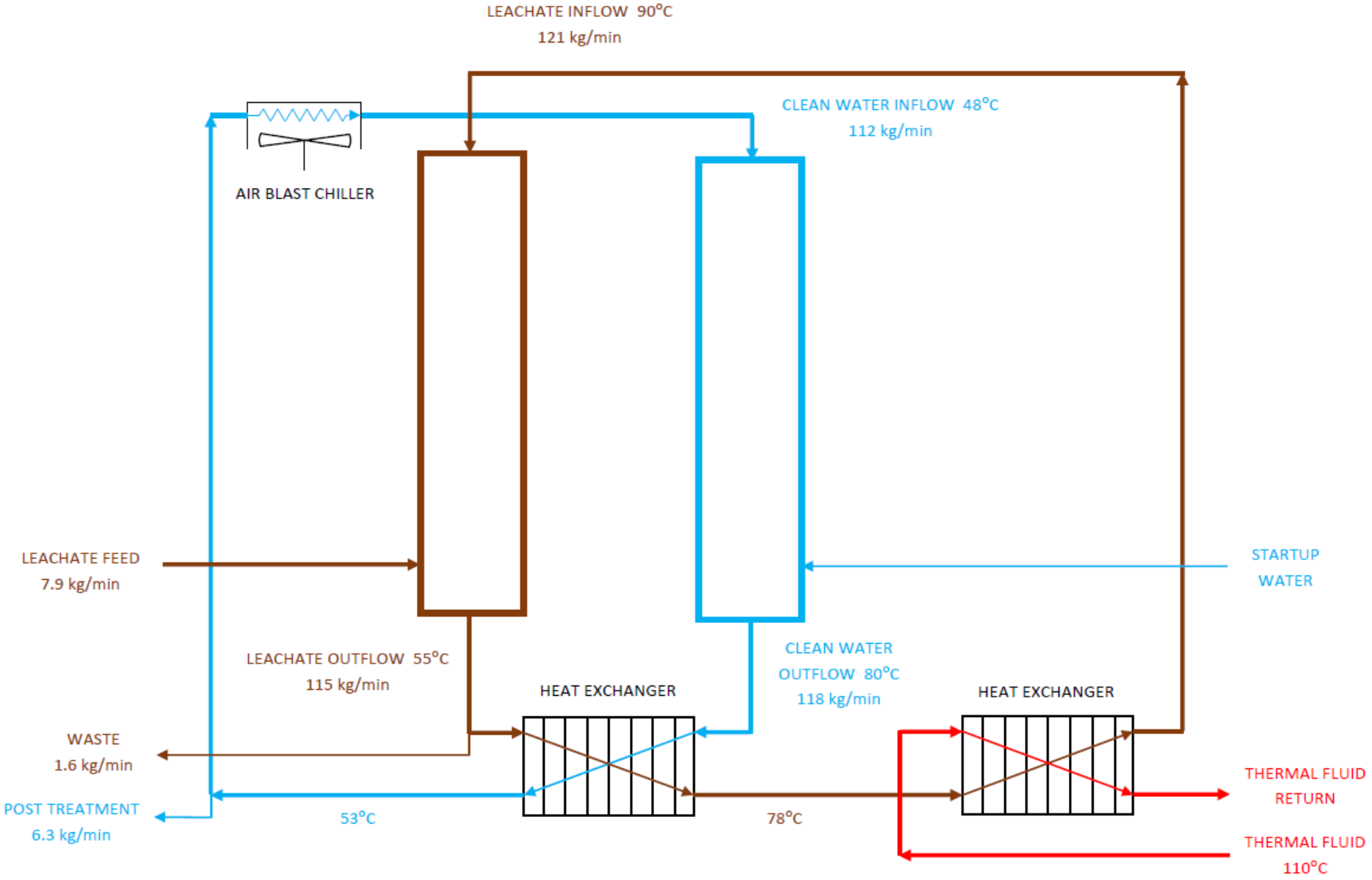

Figure 2 Simplified process flow diagram

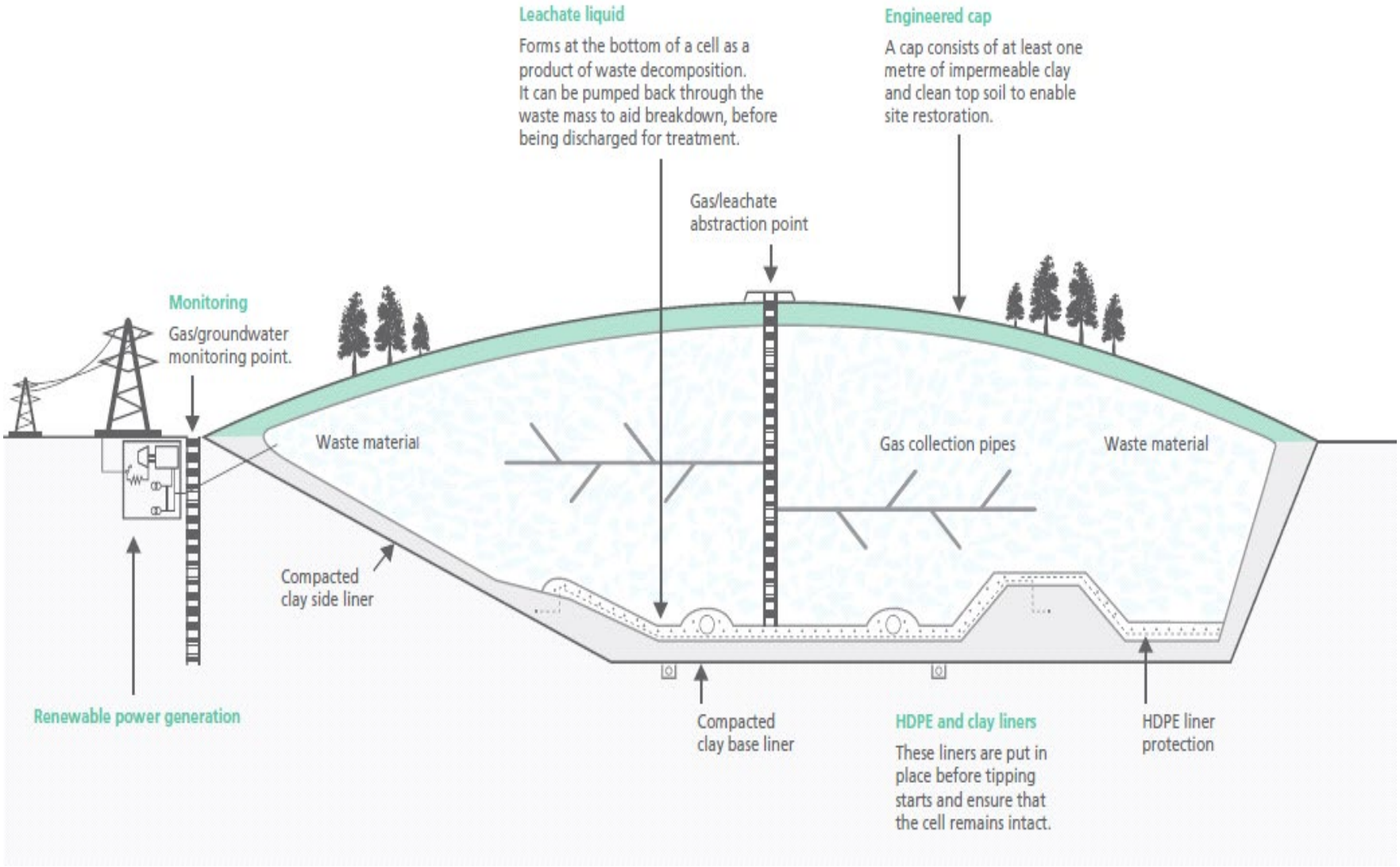

Figure 3

Diagram of Typical Landfill

Waste Heat Thermal Energy Source

Thermal energy is provided by waste heat exchanger connected to the exhaust gas of a 1MW gas generator, providing ample energy to heat the LAT™ unit.

Methane is generated in the landfill and collected via a series of pipes through the landfill site. The gas is then piped to gas generators where it is consumed and converted into electricity and sent to the grid. This conversion generates hot exhaust, which is then used to heat the LAT Water system.

LAT Water can use waste heat from a variety of sources, including exhaust gas, hot water, low pressure steam or renewable sources.

Figure 4 Waste heat recovery

Monitoring

Operation of the system is controlled remotely using a Siemens S7 PLC. During the tests daily samples were collected and tested to confirm the facility's performance. Measurements of TDS were conducted on-site, with full water quality tests completed off-site at laboratory.

The LAT™ demonstrator plant was operated with raw leachate. Process recipes were set up for water recoveries ranging from 70% to 90%. Water quality was assessed and checked against discharge and consents/permits in place. Key parameters such as pH, TDS/EC, Ammoniacal Nitrogen, COD, Anions and Cations were measured.

Standard process runs were carried out at ~70% water recovery to qualify operation over a longer duration. This approach was undertaken to assess the availability, reliability and maintainability of equipment (pumps, heat exchangers, fans, etc) as well as the robustness of the LAT™ process when treating raw leachate. Environmental performance was assessed regarding emissions to air, water, photochemical ozone creation and ("POCP") and global warming potential.

Results

LAT Water solutions are designed to operate 24/7. Reducing start-up and shutdown procedures enables the system to reach equilibrium and increases water recovery and thermal efficiencies. This is highlighted in the results below. Energy monitoring requirements were established based on a pre-agreeed Measurement and Verification Plan.

The 10m^3/day plant, as installed, delivered operating costs savings of 48%, with net savings of 11% after including all capital costs. If the unit had been sized to process all the leachate produced at the site, the operating cost savings would be 64% and the net saving 41%. This includes the cost of the electrical energy requirement of 8kWh/m3 for

Figure 5 Raw leachate (L), concentrate (C), distillate (R)

ancillary equipment including pumps and fans for the 10m3/day unit. This is projected to fall below 5kW/m3 for larger units.

	Raw Leachate	Distillate	Product Concentrate
pH	8.2	9.5	9.3
Electrical Conductivity [mS/cm]	1.3	1	16
Total Dissolved Solids [mg/L]	5,510	48	29,450
Suspended Solids [mg/L]	80	<2	96
Ammoniacal Nitrogen [mg/L]	3,410	196 *	1,481
COD [mg/L]	3,610	72	8,970
TOC [mg/L]	964	21	4,700

Table 1 Results showing characteristics of raw leachate, product distillate and concentrate

Note: Ammonia can be reduced below 2 ppm with the addition of an ammonia stripper

Savings

The unit operation of the LAT process achieved an electrical power reduction from 15 kWh/m^3 to 8 kWh/m^3 thus achieving a 48% reduction in energy use. These savings can be translated across similar sites. Baseline annual energy savings of 125,000 kWh are achieved by implementing LAT Water system for 10m^3/day unit. This equates to an energy saving of 64% versus the current processes. This energy saving is equivalent to 26.5 metric tonnes of CO_2/yr.

The energy saving potential is illustrated by the following graphics illustrating the equivalent emission savings for one 10 m^3/day unit for a year. By implementing LAT Water solutions at landfill sites across the UK, the savings would massively increase.

Figure 6 Schematic of equivalent energy savings

Source: UK Government Conversion factors for GHG Reporting

Future impact

LAT Water has focused on landfill leachate as an initial target for before rolling out the technology in other sectors. This is because:

- Leachate is one of the most challenging and complex wastewaters to treat effectively and at low costs. The successful demonstration validates LAT™'s use across other sectors
- The chemical composition of leachate has elements present in other water types - validating a wide usage
- The lack of current competitive offerings providing a simpler market entry process for LAT Water.

The process can be applied to all biologically active landfill sites. There are over 3,100 landfill sites in the UK of which c.500 are still in use - all have similar challenges with leachate treatment. Outside the UK there are several thousand landfill sites in Western Europe. Further afield in China there are at least 2,000 sites where the LAT™ process is applicable. The capacity of leachate produced ranges from 10 - 2,000m^3/day, well within the range of LAT™ units.

Leachate continues to be produced for up to 40 years after the site is formally closed, which re-enforces the requirement of long term, sustainable treatment methods. Disposal and treatment costs for leachate vary from £6.50/m^3 at large sites to up to £40/m^3 at smaller sites, and represent c 60% of site operating costs. As demonstrated at Broadpath LAT™ treatment will reduce the operating costs to the operator by over 48% from current levels.

LAT Water offers a unique solution by using waste heat on-site, resulting in major operating cost savings and sustainable, low emission technology for a wide spectrum of industrial sectors with waste water problems. Beyond landfills these include: paper, pharmaceuticals, power, mining, aquaculture, beverages, and chemicals. Many of the waste water in these industries contains valuable products. LAT Water separation technology offers the opportunity for salt and mineral recovery. By recovering both clean water and high value minerals LAT Water offer a cost effective solution and help to create a circular economy.

Innovation lessons

A key lesson from the project and applicable to many innovation projects has been the need for strong project management and control to prevent “mission creep” where specifications vary and are expanded to achieve increased “nice to have” technical desires rather than focus on the commercial needs of the project. Focusing on the innovation side of the project and relying on experienced suppliers/sub-contractors with established knowledge of best practices and designs of standard equipment, is also beneficial.

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